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The utilization of fish
by-products.
Rev. ed.

THE UTILIZATION OF
FISH BY-PRODUCTS

REVISED EDITION

National Development Bureau
Department of the Interior
in co-operation with
Fisheries Branch
Department of Marine and Fisheries
Ottawa, Canada
1928

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FISH BY-PRODUCTS



NATURAL RESOURCES INTELLIGENCE SERVICE

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P R E F A C E

The purpose of this revised edition is to direct further attention to Fish Meal, fish oil and the other by-products of the fishing industry in Canada. Though in the last few years the number of reduction plants has grown largely, especially on the Pacific coast, the value so far obtained from fish waste and non-edible fish in Canada as a whole is not what might be reasonably expected. It is hoped that the information now collected will be of use to those already interested in the fishing industry; and also to those looking for an industrial trail in certain areas not yet as beaten as it is in other countries that have also parts of the ocean as their patrimony.

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The Fish Meal, Fish Oil, Fish Guano and Fish Glue Industries

Any industry which fails to utilize its by-products for an available market is not considered up-to-date in efficiency. As an example of efficiency take meat-packing. This industry now markets every bit of the carcass; forty-eight medicinal preparations are made from the membranes and glands, the fine hairs growing inside the ears of cattle provide the artist with brushes, and the gall stones are shipped as talismans to Japan. Such a result is due to employing scientific talent, to the concentration of the industry at Omaha or Chicago, to the expenditure of much capital on plant, advertising and research, to easy and rapid collection of raw material and to an immense demand for the primary product. None of these stimuli except research are obtainable to anything like this extent in the fish industry; the raw material is more perishable and scattered, concentration in big plants is difficult, capital is scarce, though not now as shy as it was, and the demand for fish as feed is still thin. But, allowing for the special advantages in favour of meat packing, organization and science are two great factors in winning success. The waste of Canadian fish products has been patent enough to show that, if more business ability and technical knowledge were infused into the marine products industry, fisherman's and manufacturer's profits would jump, the large imports of oil would be unnecessary, exports would have a lively market, agriculture would benefit largely from the fertilizer and a more bounteous and less wasted harvest would be won from the sea whose crops never fail and entail no expense till ready to reap. Harvestry of marine products is the only method by which man can recover many of the elements essential to plant and animal life, which from the earliest geological times have been leaching from land to sea.

Parts of the world where population is still thin, where lines of communication are irregular and where there are copious supplies of natural resources to exploit and ship en masse to profitable markets are naturally careless of subsidiary products. It is only when labour becomes more abundant and profits fall because of competition that men look to the waste. The discarded 'tailings' of a mine, the offal of an abattoir, or the sewage of a city are then worth notice and it happens that the output from a once despised by-product may affect the balance of profit and loss.

For example take the fishing industry of British Columbia:-

Exclusive of about 400 whales, which are not fish, and whose 'whalebone', bones, oil and flesh for food, meal and guano alone make them a valuable catch, it is only in the last 25 or 30 years that British Columbia has thought it worth while to make a profit from its abundant fish except in the way of marketing for food. The sockeye and spring salmon and halibut were in former years far more than enough to keep all the canneries and fishing boats busy marketing at high profits, so that even the less popular kinds of salmon and other fish now marketable were discarded. The offal from the dozen canneries at the mouth of the Fraser could only be got rid of by sending it off on scows to be dumped at sea, where it fed the robber fish, shark and seals that lurk for the salmon run and for the sockeye fingerlings starting on their four-year trip to unknown waters. It was not till 1898 that the first reduction plant was put up, but these are now in operation at most cannery centres.

The Waste - In 1918 inquiry showed that the available raw material of fish waste was 250,000 tons; of British Columbia Pacific salmon 46 per cent. of the fish was wasted; of the Canadian lobster pack 75 per cent.; of Atlantic dried fish 45 per cent.; that halibut heads equal to one-sixth of this fish's weight were thrown away and that 25 per cent. of the total of fish caught was unused.

In 1928 the waste is less but still far too great. The value of the by-products in Canada in 1923 was only 1.2 per cent. of the total value of the fisheries; in 1925, 2.45 per cent.; in 1926, 3.66 per cent. In the United States it was 15 per cent. in 1925.

A Canadian delegate to the Imperial Economic Committee reported that:-

"In England through scientific research all the fish which goes to market on this side of the Atlantic is manufactured into some form or other and practically every part of the fish is consumed." (Can. Fish. Sept. 1927, p.274.)

In order of bulk and availability the raw material that is or should be used may be thus set down:-

- (a) Surplus of edible fish beyond demand for consumption, especially pilchard and Pacific herring.
- (b) Waste after canning and curing of salmon, cod, haddock, hake, halibut, 'sardine', cisco, whitefish and others.
- (c) Non-edible fish viz. dog-fish ('mray fish'), sharks, porpoises and all other fish now thrown away.

By provinces the ratio of by-product value to total value of fisheries in 1920 was:-

British Columbia	5.0 per cent
Quebec	2.4
Nova Scotia	2.3
New Brunswick	1.4
Prince Edward Island	.0

There are areas in all these provinces where further reduction plants might be profitable, notably in Prince Edward island, northern British Columbia including Queen Charlotte island, and parts of New Brunswick, eastern Quebec and Nova Scotia.

Shark and Dogfish

The wholesale killing of shark and the dogfish that ravage the fisheries off both coasts like packs of wolves is not only vital to the increased supply of edible fish but would yield an abundance of oil, fish meal, fertilizer and glue. An experiment in shark fishing carried out by the British Columbia Department of Industries in 1920 is very suggestive. One boat with a crew of 5, fishing for 24 days, took 357 sharks. The running expenses, exclusive of wages, were \$311, and the value of the shark-liver oil, hides and fins (for China market) was \$1,600 or more. No account was taken of carcasses which had to be thrown away in the absence of facilities for producing a large amount of oil, meal, and fertilizer whose value would amount to at least \$600. "All persons connected with the industry" says the report, "are convinced that there is a big future ahead of any company engaging in shark-fishing utilizing all the products in the production of oil, fish-meal, hides and fins." (For details see Report of British Columbia Department of Industries, 1922, N. 20-26).

In Australia the capture of sharks has become a large industry, employing the finest steam pleasure yacht yet built, which after doing good service in the great war has now been converted to fight the shark. The works for utilization of the products are 80 miles from Sydney, N.S.W. The fins are graded and exported to China; the hide, taken off in one piece, is a valuable leather when tanned; the flesh is dehydrated for Malayan and African consumption, and the oil from the livers finds a world market - ('Canadian Fisherman' 28/1/28).

Copenhagen reports in 1927 that the use of shark's skin in the leather world is developing into a large industry. The Danes have solved the problem of removing the horny plates or bony substances from the surface and obtain a skin as soft as morocco; the oil is used in the margarine, soap, paint and leather industries, the residues for hen's food and as insulating material. (Chris. Science Monitor 1927). As a French writer says 'quand un cochen est utilisé, il ne reste que ses cris; dans le requin (shark) il ne reste rien du tout.'

The following extract from the 1926-27 Report of the Fisheries Branch of the Department of Marine and Fisheries indicates that the dog-fish is a curse alive but a blessing and profitable dead:-

"The dog-fish (*squalus sucklii*) is plentiful on the Pacific coast and on account of its voraciousness has become a pest. Many

Attempts have been made to utilize it and thus protect more valuable food fish. Plants erected for the production of dog-fish meal and oil have never been very successful, largely because of the inadequate methods used. The Prince Rupert station has undertaken an examination of the production of oil and meal with a view to improving the methods as to make the reduction of dog-fish profitable. This work is being conducted by Mr. H.M. Brocklesby.

A thorough chemical examination of the oil has been made and forwarded to the Journal of the Society of Chemical Industry for publication. Amongst other things it was found that this oil lends itself very rapidly to sulphonation, a process which makes it very valuable to the leather and tanning industries, which have not used it heretofore because of its objectionable odour. This however is removed by improved processing, which also makes it more valuable for use in outside and heat-resisting paints.

When hydrogenated, this oil forms an odourless, tasteless, pale yellow, edible fat, which could be used for food purposes. This fat could be used in the manufacture of fine toilet soaps, while the unhydrogenated oil is valuable for the production of washing powders and laundry soap. Thus numerous new markets for the oil might be found as a result of improved methods of manufacture.

Examination of the vitamin potency of the oil shows that dog-fish oil is more potent in vitamin A than is standard medicinal cod liver-oil as prepared by Park Davis Co. This work was made the subject of a paper which has been forwarded to the Journal of Biological Chemistry for publication. An assay of Vitamin D is now being undertaken both at the Prince Rupert station and at the Manitoba Agricultural College, where Mr. F. T. Nutt is experimenting with young poultry. The results obtained will first be published in technical form after which they will be embodied in a more general paper for the use of the trade". (p.92).

About ten years ago the Dominion Government experimented with reduction plants primarily for dog-fish in the Maritime Provinces. Owing to expense of intermittent operation, low market value of fertilizer and oil products and cost of raw material the two plants were closed or passed into other hands. Under present conditions plants using improved processes, taking care of all waste fish at all seasons, and producing meal, oil etc. of high grade, and having the benefit of experience are now profitable.

In 1925 the value to Canada of the raw dog-fish used in oil and guano production was \$22,212, in 1926, \$23,634.

Pilchard and Herring

It is however from the pilchard reduction plants now operating on Vancouver island that the fish-by-product industry in British Columbia is mainly realising its big revenue. Of these there are now a score on the island, almost all of them licensed in the last two or three years. This sudden development of the industry is due to a decision by the Dominion Department of Fisheries to allow the pilchard to be caught and used for other purposes than for edible food. The pilchard is a grown sardine. The 2½ to 4½ inch sardines that move north in vast shoals up the Pacific are caught in large amounts at that stage of growth on the California coast; by the time they reach the straits of San Juan de Fuca they have grown to double the size and are then classed as pilchards, just as the pilchards caught off the Cornish Coast are grown sardines that have escaped the nets on the European Atlantic Coast from Gibraltar to the Channel. On the Pacific coast as on the coasts of Cornwall the shoal movements of the pilchard are a matter of lock out rather than knowledge.



In Canada there was and still is a very limited market for canned pilchard, as the consuming public do not yet generally realize how good it is and buy the expensive canned salmon or salt dried cod by choice. Rather than allow the pilchard harvest, which cannot be drysalted like the herring, thus to waste, it was wisely handed over for use to reduction plants with the result that in 1926 there was an oil production of 2,630,183 gallons and 11,273 tons of fish meal of which pilchard supplied 1,933,680 and 8,414 respectively. As the herring supply is in most years more than enough to fill the demand for dry salted herring in the profitable market of Asiatic countries, herring may also be used for oil and meal in Districts 1 and 2 in B.C. of British Columbia waters but not in District 3 (See page 16.) Herring may also be used for this purpose to the Bay of Fundy waters adjacent to New Brunswick, and spring herring caught on the Atlantic coast.

The Canadian National Railways are reported as building fish-oil storage tanks at Victoria, B.C., with a capacity of 300,000 gallons. The Canadian Pacific Railway is reported as fitting one of their coast-wise steamers with tanks for 170,000 gallons and tank steamers are run by the Waterhouse Co. carrying 40,000 to 80,000 gallons.

The boat building industry of British Columbia has been much benefitted by this new field for the fishing industry.

Prospects

Much progress has been made since the Report of the National Research Council in 1921, and the recommendations then given, especially in the line of improvement of processes, are now adopted. Though the fish by-product industry is no longer neglected even on the Atlantic coast of Canada, both there, and on the Pacific as well, more concentration, coordination and cooperation would make it far more important and remunerative.

On both coasts there have been, and still are, difficulties in the way, but they are not insurmountable. On the Atlantic the chief obstacle is the distance between the sources of supply and whatever by-product factories there are. The vast amount of unmarketable fish taken in deep-sea fishing on the Grand Banks must still be lost unless low temperature storage room is available on the schooners or the scheme of fast-collecting boats to take fish promptly to the market is realized. A thing to be desired is cooperation of capital and labour within the industry, which should control for its own benefit the buying and selling, production, and, as far as possible, the transportation. A well organized and all-embracing company could establish in most fishing areas along the coast primary reduction plants to which the non-edible fish and the waste could be speedily brought. The primary products---crude oil and dried meal---could then be brought from these scattered plants to a central refining factory where high-grade oil, fish meal, guano and glue could be efficiently manufactured. Such a scheme would embrace the supply not only of the ground fish, cod, halibut, haddock, hake, plaice, etc., which are permanent off the coast, but the "school fish", herring, mackerel, sword fish, tuna, etc., which move along the coast at uncertain times, and also the non-edible fish. Considering that on the Canadian Atlantic shore alone there are 600-700 canneries and the supply of waste material is superabundant, such a source of wealth cannot long be neglected. The "Atlantic Experimental Station for Fisheries", lately established at Halifax, offers valuable assistance in scientific methods of treatment of by-products.

In British Columbia waters the difficulties are somewhat less because of the closer concentration of canneries at the mouths of the Fraser, Skeena, Naas and large inlets, and because the mild climate and sheltered waters should make the supply of various fish continuous. As matters now are, when the waste of the halibut and salmon industry centering at Prince Rupert is not available, the by-product plants must either shut down or be dependent on a fitful supply of dog-fish. A

comprehensive organization adequately capitalized and cooperation with the fishermen could meet such difficulties by a plan similar to that suggested for the Atlantic coast. The benefit of a concentration is exemplified by the case of the Consolidated Whaling Corporation which, working in and from two or three centres, obtains by-products from about 300 to 400 whales far in excess of the similar by-products handled by all the other isolated fishery concerns. The Experimental Stations at Nanaimo and Prince Rupert paralleled the aid to research offered by that in Halifax.

Owing to the concentration of canneries on the Pacific coast and the limited area in which the pilchard is known to run, the British Columbian reduction industry has developed further than that in the Atlantic provinces, but the comparative nearness of the European market to Halifax, or Saint John may well outweigh the handicap of dispersed supplies and the resulting difficulty of collection at central reduction plants. These are slowly increasing in number in New Brunswick and Nova Scotia, as the fishing industry cannot well afford to perpetuate the disregard of waste.

At the present time (1927-1928) there are 15 licensed plants operating on fish by-products in Nova Scotia and New Brunswick, but there is none as yet in Prince Edward Island nor in Quebec. Of these plants only four produce fish meal in any quantity, three at the most produce fish guano; the others prepare fish oil and cod liver oil, crude or medicinal. One plant uses the scallop and clam shell waste from canning factories in preparing a grit for use in the poultry industry. Besides the licensed plants there are several concerns which collect livers in barrels and render the oil by the old-time method of putrefaction. A bucket of livers is sold for 20-25 cents and oil drawn out by the sun for 30 cents a gallon.

This extract from the special report of J. J. Cowie and G. R. Earl, Canadian delegates to the Imperial Economic Committee of 1927 emphasizes the need of plants for fish meal, of which oil and fertilizer are corollaries:

"There is a great and ever-widening market for fish meal of the desired quality.

"The throwing away of 30 per cent of the large quantities of fresh fish brought to land by our shore fishermen is a serious loss which might readily be avoided It is well known that at present when dogfish come on the coast fishermen practically stop operations rather than continue hauling up their lines loaded up with these fish and with very few of the food fishes. But if the shore fishermen were once assured that they could dispose of every dogfish at a price to a meal-making plant, in addition to the benefit they would derive from the increased quantity of edible fish they would bring to land, their outlook and material state would quickly change

"We strongly feel that the establishment of central meal-making plants on the Atlantic coast is of as much importance as the finding of new markets for fish

"To summarize the main features of the foregoing report which would bring immediate beneficial results, we would note that these are two:

- "(1) The marketing of fresh fish in ice in Great Britain and
- "(2) The establishment of meal-making plants to take care of the great amount of material at present being wasted."

Reduction Processes

In the past much capital was lost in desultory efforts to equip plants for handling waste offal and non-edible fish. The basic causes of failure were the crudity of the processes and the consequent inferiority of the products. The British Columbia representative on the Chemists Committee of the Advisory Research Council stated in 1921 that, "until a semi-commercial plant is erected to demonstrate that a better process than those in use can be developed, that yields can be increased and operation carried on cleanly for a market, it would seem to be futile to continue the erection of other fish-rendering plants."

Since those days the fish reduction industry at least on parts of the British Columbia coast has been wholly remade mainly owing to the permission to use pilchard and in certain districts herring for non-edible purposes and to the consequent demand for up-to-date equipment. Capital has again flowed in; the products are more standardized; scientific knowledge is more and more applied; there are as many fish as ever; the campaign against their marine foes has hardly begun, and there is still a vast amount of waste that should not be wasted.

Owing to long experience in by-product reduction of menhaden, salmon, herring, sardine, tuna, etc., in the U.S. and Alaska, and of cod, hake, herring, etc., in Norway, Britain and Germany, manufacturers of special machinery outside Canada had a great start specially on the Pacific Coast. Well known firms attracted by the free admission of machinery not made in Canada for the manufacture of meal and fertilizer have so far held the market, but one or more of these firms have now established branches in Canada, and certain Canadian firms are now well prepared to compete with them.

The main cost of a plant naturally depends on the capacity, varying from some \$200,000 upwards for a big fishing and canning centre to \$25,000 or \$30,000 for a completely equipped plant (exclusive of land and foundation) capable of handling 200 tons of raw fish a day, or to units for 2, 4, 6, 10 tons per hour at a cost of \$10,000 a 2-ton unit. The latter are specially suited to isolated canneries, dog-fish and halibut-waste centres, and collecting stations on an out-of-the-way coast.

The use of pneumatic conveyors for fish meal is common in the Alaska herring industry and is likely to be general in all large plants. Besides being the fastest and cheapest method of handling all finely separated material from metal filings to sawdust, this process has a special advantage in moving fish meal in that it counteracts the natural moisture and warmth of the meal.

A suggestion of the Imperial Economic Committee might be worth consideration, namely, that of a factory ship, equipped for the treatment of edible fish for prompt despatch and carrying on the first stage of reduction of non-edible fish, livers and offal into oil and meal.

(Can. Fish - Dec.1927, p.360)

The typical processes are of three kinds:-

- (1) The raw material is cooked with live steam; the oil and water are removed by a press; the press cake is dried; and the oil and water are separated by heat. This long established method loses a portion of protein by pressure, and gives a somewhat low yield of meal averaging one ton of meal to six tons of fish.
- (2) By the dry-rendering process the fish can be sterilized before drying. The drying is effected in a steam-jacketed vacuum drier, and the oil is then removed by a screw press.
- (3) The solvent process much used in Europe is both efficient and economical. Cheap solvents such as ethylene dichloride and trichloroethylene, which are non-combustible and non-explosive, are now produced on a large scale and are recoverable after use with little loss. The fish is dried before treatment with solvents.

It should be noted that modern fish rendering equipment is of the enclosed type with suitable arrangements for drawing off and burning

the noxious vapour. A nuisance can thereby be avoided.

Reduction plants are now installed in various areas of both coasts and at certain canneries. An account with drawings of a type specially adapted by its compactness and moderate cost for fish curing establishments and fish canneries is given in "Chemical and Metallurgical Engineering" for October 29, 1923 and December 8, 1924.

The necessary machinery can be manufactured in Canada or imported from Great Britain but certain firms in the United States which have long specialised in the equipment have as yet the greater share in the west.

Imports of equipment for the industry in 1927 amounted to \$293,507 compared with \$18,335 in 1925.

Besides the information as to this and other equipment features of fish-rendering plants to be found in the references to books and articles listed later in this memorandum, those interested may obtain practical advice from the Fisheries Experimental Stations at Halifax, N.S., Prince Rupert, B.C., and Nanaimo, B.C.

Fish Oils

(Marine oils)

For specialised knowledge of the fish oil industry the reader is referred to text-books on the subject (see p. 25.)

We confine ourselves here to a summary of the fish oils known to the trade and such facts as are applicable to the present status of the industry in Canada.

Oils derived from fish are broadly divided into:

- (1) fish oils obtained from all parts of the body of a fish,
- (2) liver oils:-
 - the chief of which are
 - (a) 'cod oil' i.e. non-medicinal cod-liver-oil.
 - (b) medicinal cod-liver-oil:-
 - other special varieties are
 - shark liver oil
 - dog fish liver oil.

(1) Fish Oils:-

The most important fish oils are

- salmon oil
- pilchard oil (sardine)
- herring
- menhaden (U.S.L.)

Mackerel waste, tuna, dog-fish and other fish taken in smaller and scattered quantity, are usually mixed before reduction, and the oil product is classed as 'fish oil' generically.

The bodies of cod, halibut, and other white fish yield little oil, as do the livers of fatty fish, and vice versa.

The differentiation of 'fish (body) oils' in Canada is so far confined to 'pilchard oil' and probably 'salmon oil', the body oils from other fish and other fish offal being marketed as 'fish oil'. This statement applies also to the porpoise for though an oil obtained from the jaw is of very high value as a lubricant, the number of brown porpoise taken does not warrant separation of the jaw oil from the body blubber.

An addition in Canada to the raw material for fish body oil may in time be made by an increased capture in the Arctic waters of the walrus and the porpoise known as 'White Whale', which is also taken in the Gulf of St. Lawrence. Before the pilchard industry was developed in British Columbia the oil production from marine sources was mainly confined to whale and hair seal. A large amount of whale oil (1925, 556,939 gals., 1926, 468,206 gals.) continues to be produced by the Consolidated Whale Corp. of B.C., and the seal oil production of Quebec is still considerable (1925, 10,391 gals., 1926, 8,265 gals.)

Uses of fish body oils

The body oils of the fish above named are classed as 'drying oils' and can be used in the paint and varnish industry according to their relatively high iodine value.

These fish oils are also used in the soap and leather, rubber, waterproof material and cordage industries.

The hardening and deodorizing of fatty oils by hydrogenation have been perfected of late years, so that hard colorless, odourless fats are now manufactured from fish oils. This is particularly the case with menhaden and whale oils, the product being used in the manufacture of candles, laundry soap and in preparation of lard substitutes, one of which made from Pacific coast herring has also found a market.

As the modern process of hydrogenation depends on an economical production of hydrogen electrolytically and the use of a nickel catalyst, Canada might well be able to hydrogenate her oils instead of shipping for treatment abroad.

A novel use of fish oil may come about from a report of French investigators to the 'Academie des Sciences' that it can be used in Diesel motors.

Fish Oil for Hydrogenation and Edible Use

Hydrogenation of marine oils will destroy all odour and bleach them snow white, but leaves them hard and unsuited to the manufacture of edible products such as lard and margarine except absolutely free of fleshy or protein matter, which owing to the action of enzymes destroys the keeping quality. Purification can be effected by the use of Filter Cel, the cake of which after use is added to the fertilizer stock.

Whereas salmon oil from fresh fish as found in a can of salmon is very edible and contains only one per cent or less of free fatty acid, the oil usually obtained from salmon offal contains from 10-20 per cent and is often rancid and odorous. It is, therefore, essential to handle the raw material promptly before decomposition is possible, if a high grade oil is to be produced. Besides the higher value of the oil the grade of meal thus rapidly produced fetches higher price and meets the critical demands of the poultryman and stock feeder.

The general public will not have any aversion to cooking fats made from fish oils if properly made at first. The scientific treatment of cotton seed oil has long ago overcome the prejudice created by crude methods of production. "The fish is cleaner as a source of fat than most animals. It can never be as filthy as the hog."

"If fish fats could be offered to the average consumer in an attractive and palatable form at a price not in excess of that of commonly used fats, they would be used for cooking in constantly increasing quantities in spite of any personal prejudices The hydrogenation of fats is doubly successful. First, it deodorises the fat, and secondly, by this process it is possible to harden the liquid fats to the consistency of lard..... When economic conditions demand it, chemists will be able to transform fish fats into products suitable to the consumers' taste; it is evident that there must be an increasing

supply of edible fats, for the present day dietician feels that the human diet, to be satisfactory, should contain a certain percentage of fats. It therefore appears to be only a question of time until fish fats will be more extensively used in the human dietary."

(A.D. Holmes, U.S. Bureau of Fisheries, 1926).

The process for the proper treatment of salmon, pilchard, tuna, whale and other oils is described in detail by Chas. V. Zoul in the 'Canner' for 1921.

Liver Oils

The fish-liver oil industry in Canada is confined to cod, hake, and haddock, special attention not having yet been paid to dogfish or shark livers.

Both in America and Europe, codliver oil for industrial use is known to the trade as "cod oil". "Cod oil" is of two grades, first a high grade prepared from cod livers more or less fresh, which is known as "crude cod liver oil" or "non-medicinal cod liver oil", and secondly an inferior grade derived from a mixture of cod livers with those of hake, haddock and other fish (known in Europe as "coast cod oil"). "Cod oils" form the bulk of the industry in Canada, Newfoundland, Scotland, Maine, Massachusetts and Japan; on the other hand, in Norway and Iceland medicinal cod liver oils are the larger product.

The production in Canada for 1925 was 274,987 gallons of cod oil and 26,836 gallons of "medicinal". In 1926 the respective figures were 201,439 and 94,383.

Uses of "cod oil"

Cod oil is in general use for the leather industry and in the manufacture of low grade soaps and oil cloth.

A special use is in the preparation of 'chamois' leather from sheep skins. The excess oil, when expressed, is called degreas and is used by curriers and leather makers.

Medicinal Cod Liver Oil

The question whether there ever can be in Canada a medicinal cod liver oil industry at all comparable to that in Norway or even Newfoundland depends on the potential supply of suitable raw material.

Science tells us that cod liver oil however rich in fat, however nauseating or tasteless, however brown, yellow or colourless, owes its specific medical value to its vitamine content and in a lesser degree to its iodine value (155-161). To know the origin of the vitamins in fish oil is, therefore, essential, and the "flow sheet" below becomes of great practical interest.

Genesis of Vitamines in Fish

- (a) the sun is the primary visible source of energy;
- (b) only at shallow depths to which rays penetrate, e.g., the "banks", at mixing points where conditions allow the upper layers of water to be replenished with the salts necessary to plant life, parts of the North sea and the coasts of Newfoundland, can marine algae (i.e., diatoms or microscopic vegetable organisms with siliceous coverings) synthesise the vitamine;
- (c) these diatoms are the food of minute but larger creatures (copepods, amphipods, larvae, decapods, mollusca, etc.);
- (d) these in their turn are the food of many varieties of small fish and other marine creatures (caplin, squid, salpae and certain molluscs);
- (e) these are the food of the cod;
- (f) cod is a food of man.

In view of the small demand in Canada for cod and other roes, it should be noted that vitamines is not confined to the liver, but in the period preceding spawning is found considerably concentrated in the roe both hard and soft. (British Medical Research Council Report No. 38, 1924 p.29.)

Those interested in the medical cod liver oil industry of Nova Scotia have to ascertain whether the livers of the cod used as the raw material meet certain conditions and whether a supply of such livers can be obtained large enough to support an important industry. The great increase in the amount of medicinal cod liver oil produced in Nova Scotia in the past few years is certainly an indication that this natural resource had not been utilized to the full; nor is it yet.

The demand for cod liver oil has never slackened and, considering the increasing use in animal feed (for cattle, horses, sheep and poultry) will increase even if science presents the public with a more tempting substitute. At the present time it is most unlikely that any equally potent edible substance can be produced in quantity large enough to take the place of medical cod liver oil, but it may be noted that the Medical Research Council has reported (1927) that the liver fat of salmon and halibut may be a hundred times as rich in the growth promoting vitamines A than standard medicinal cod liver oil; again that the Biological Board of Canada has stated that dog fish liver oil is even more potent in vitamines A than cod liver; and further that professors of science declare that the anti-rachitic vitamines (by some termed D but not yet definitely differentiated from vitamines A) is formed by the exposure of fat like substances to ultra-violet rays and that .0002 milligrams of a compound named "irradiated ergosterol" fed daily for a period has a like healthy effect on animal bone growth. Even if as stated the liver fat of calves, cows, etc. yields a tasteless oil quite as rich or richer in vitamines A than cod liver, the cost of the supply and the limited amount would bar it from competition.

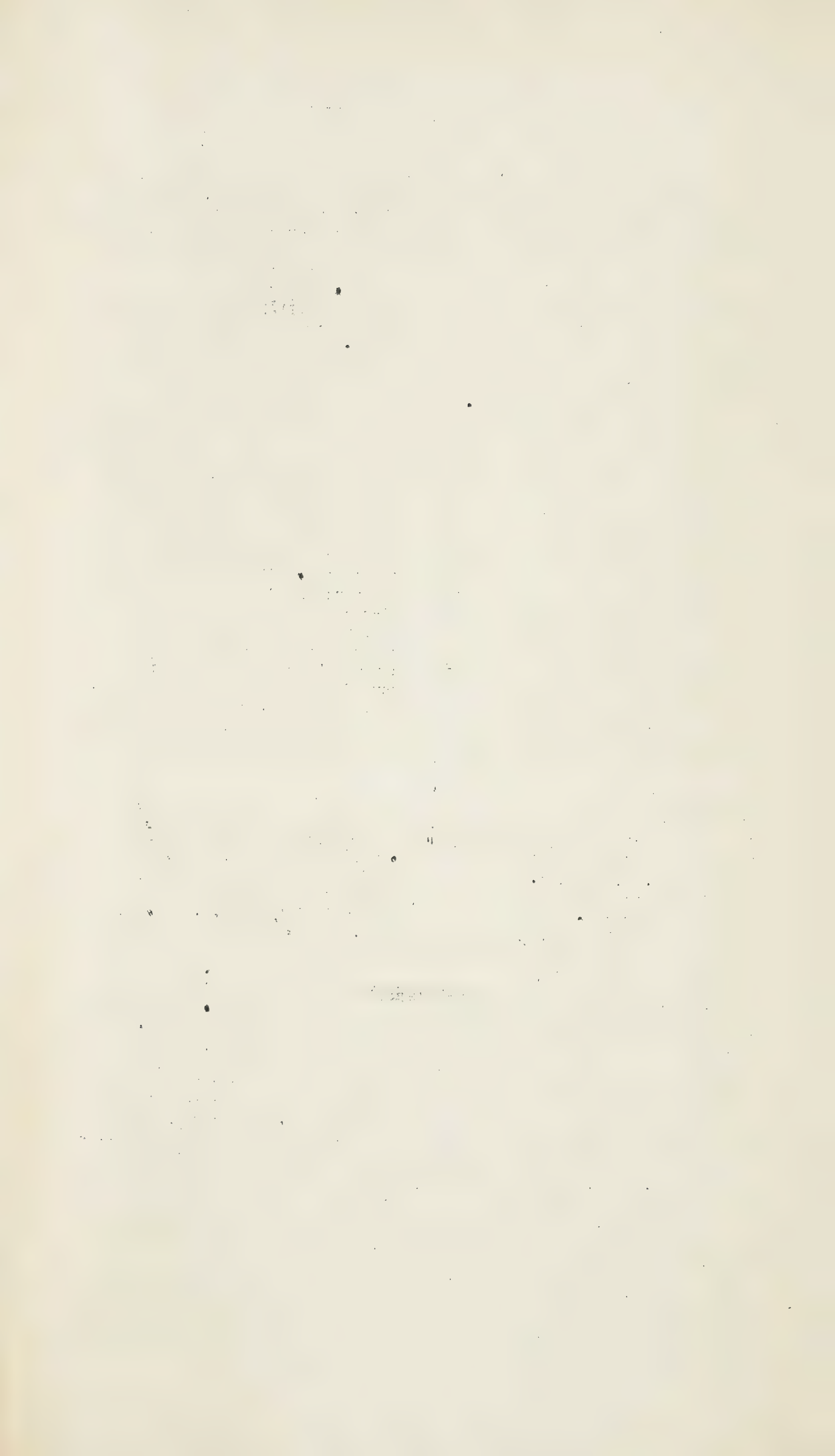
Atlantic Cod

As to the relative merits of Norwegian and Newfoundland medical oil, the result of the discussion may be summed up in these words:- "the superiority of the Norwegian oil has disappeared through the improvement of the quality of the Newfoundland oil" (Imp. Inst. Bulletin No. 4, 1925, p.470) and even Professor Poulson the Scandinavian expert writes that "oils from Newfoundland and Norway are equal as regards content of vitamins and variability" (i.e. colour, taste, and smell) (Can. Fisherman 27/4/28). Further extracts are these:-

"The Newfoundland oils were found to possess a very high average vitamines content and this is ascribed to the fact that the main fishing is in the summer months when the cod are actively feeding off the east coasts of the island"....."of the oils derived from Norway those from the----coast which are prepared not only from the cod, but also from various other ganoid fish caught when actively feeding are, generally speaking, five to ten times more valuable than the average oil prepared in----the area, where during a portion of the season the fish are caught when spawning"...."only a very small proportion of the fish used for the manufacture of Norwegian oils are caught when spawning"....

"The oils from Newfoundland are prepared practically entirely from cod". (Imp. Inst. Bulletin.)

"The Newfoundland livers are at their best after feeding on the caplin and squid, which have themselves fed on the diatoms and plankton. The caplin appear in shore-waters in June and July and after them the squid. After the cod have spawned in May they feed and fatten in June, July, August and early September. The livers are rich in vitamins A and D, which carry them over the next winter and spawning season." Experts agree that the best oil is from cod which have been bled by cutting their throats when taken. Those left to die are not as good. (Fisheries Resources of Newfoundland by Michael Coulon, 1925).



"The Newfoundland oils have the quality of vitamine content, but in spite of the system of government regulation and inspection the oils do not find a ready sale in Great Britain in competition with the highly marketable Norwegian produce. The price also is often high. The key to the matter would seem to lie in exercising greater care to ensure that only the clear colourless oil which is drawn off at the beginning of the steaming is placed on the market as medicinal oil." (Imperial Economic Committee's Report on marketing foodstuffs within the Empire.)

A perusal of the above extracts will draw the attention to those interested in the Canadian medicinal cod liver oil industry to certain conditions that make for a product of the highest grade, (1) that the fish must be taken before spawning and while still actively feeding, and that if this condition is fulfilled the livers of certain other fish besides the cod may be equally valuable, (2) that the rendering of livers should be effected as soon as possible after the fish is caught, (3) that great care should be taken to market as medicinal oil only the very best oil obtained by scientific process.

A corollary from what we have stated above is that a scientific analysis guaranteeing the vitamine content of the medicinal oil is essential if the unfounded prejudice hindering the marketing of Atlantic cod liver oil is to be removed. (In this connection it may be noted that the well known expert Dr. J. C. Drummond is reported to have invented a "tintometer" which indicates the vitamine potency by variation in a purple shade. Canadian Fisherman 27/4/28.)

The Imperial Government promises that if the production of medicinal cod liver oil with high vitamine content is carried out to its satisfaction, the Empire Marketing Board will advertise the facts and work up a greater demand for the north Atlantic product.

In Norway the medicinal oils produced in the Lofoden and Finmarken zones are bought in bulk and shipped to Bergen and other centres for the refining process which, undertaken as far as possible to avoid oxidation by contact with the air, consists in the removal of the stearine and pigment. Newfoundland of late years has treated part of its oil thus, but the bulk of the higher grade oil has been shipped to Boston and Europe for refining. There seem to be no reasons other than economic why a plant going beyond preliminary processes should not be put up in Nova Scotia to take care of the livers obtained on the banks and refrigerated for transport and also of the fresh livers from cod gutted for curing at Halifax, Canso, Lunenburg or Digby, provided the fish are in prime spawning condition.

(Note: The Geological Survey Report 1888-9, Vol IV, p.91 had an interesting item, viz. that the waters of the alkaline medicinal springs at Apchaqui and Havelock Corner in King's county, New Brunswick, make a natural emulsion with cod-liver oil.)

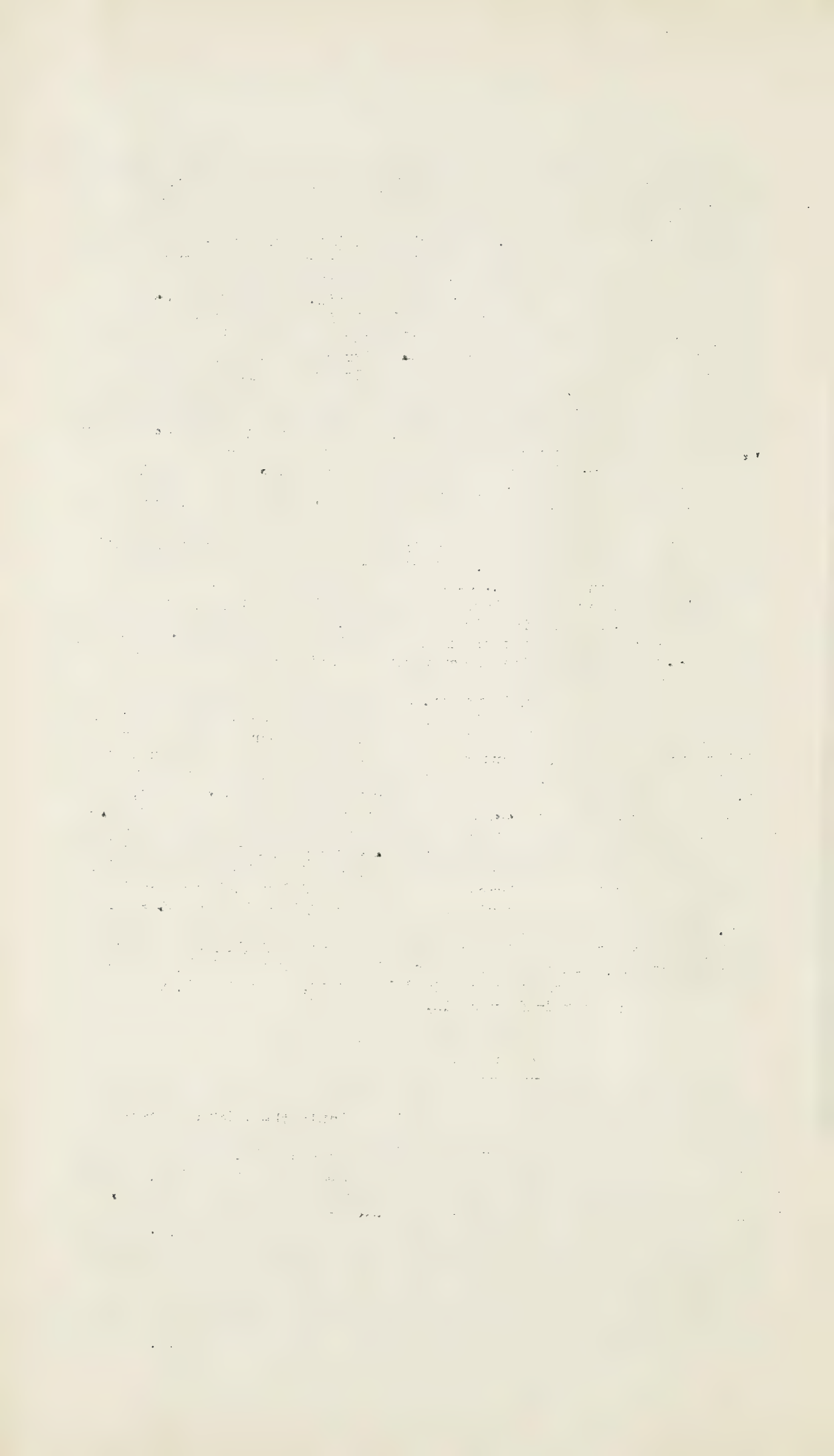
Fish Meal

Fish meal has now wide use as an ingredient in the feed of cattle, swine and poultry.

Formerly nearly all the fish waste, if used at all, was reduced to fertilizer (guano) after the expression of as much oil as possible, but it is now realised that, besides the higher price paid for meal than for 'fish scrap', the most valuable chemical constituents of the raw material are mostly returned to the land in the manure of the animals fed.

As a feed stuff, fish meal should be carefully treated, prepared from fresh raw fish or fresh offal in a clean factory and should be dried without scorching. The richer meal is made from whole fish, the poorer from waste heads, tail and fins. Meal can be made from salt-water or fresh-water fish alike.

Its feeding value depends on a high content of protein, i.e., tissue-building albuminoid (55-60%) which renders it more suitable for combination



with such feed as roots, potatoes, hay, straw and the starchy cereals, all of which contain a low percentage of protein. Besides the high albuminoid content, a good fish meal food should contain less than 10 per cent oil, 3 per cent salt and 14 per cent moisture, and should be ground fine, be light in colour and mixed with certain other ingredients (molasses, bran, etc.) in proper proportion. If too moist the feed becomes mouldy and an excess of oil, especially if the raw material is not quite fresh, imparts an unpleasant taste which may taint the flesh of the animal fed. Subject to these conditions there is a large and growing market. (See Dominion Experimental Farm Pamphlet No. 17.)

A recommendation in the Fish Report of the Imperial Economic Committee (Oct. 1927) reads as follows:-

"It is necessary for the economic development of the industry to exploit to the fullest extent the by-products. White fish meal has special value for feeding animals and poultry. While there is a large market in Germany for fish meal, certain of the meat trades in Great Britain have opposed its use on the ground of its inducing taint. Repeated experiments at research stations have demonstrated that there is no risk of taint, if the meal is used in the proportions and in the methods advocated by the English Ministry of Agriculture and Fisheries. The opening for an extended use of fish meal in Great Britain is very great and its development would benefit both the live stock industry and the fishing industry." (Can. Fisherman, Oct. 1927, p.296.)

The Canadian Trade Commissioner in Germany reported in June 1924, as follows:

"The establishment of plants for drying and grinding fish waste into fish meal for export to Germany would appear to be the best outlet for the refuse of Canadian canneries; practically all the raisers of swine in Western Germany are accustomed to use fish meal which is also sometimes given to young cattle and poultry."

Germany and Britain compete for the Norwegian cod meal which is white, flakey, air dried, and analyses only about 3% fat. Norwegian herring analysing about 9% fat is less favoured. The white fish meal of Britain and Germany is similar to the Norwegian but is not as attractive in appearance.

Meal derived from 'yellow' or oily fish such as salmon, herring and mackerel, is less valuable than that from 'white' fish such as cod, haddock, halibut, flat fish or lobsters, because of the higher percentage of oil remaining in the meal.

A booklet describing the scientific German method of processing fish for meal whether by indirect steam or solvent can be obtained on loan from the Intelligence Service of the Department of Trade and Commerce, where samples of good Scotch fish meal can also be seen. (Reference file T.C. 20382).

Fish Guano

Fish "guano" or ground fish scrap "consists of fish tissue, fish bone and fish waste, dried and ground and shall contain not less than 5 per cent of nitrogen and 5 per cent of phosphoric acid." It should be distinguished from fish meal, which, though it is also "dried ground residue from fish" must, by the "Feeding Stuffs Act" of July 1, 1920, "be made from undecomposed fish and the oil contained therein shall not be rancid."

"In the manufacture of this material the offal--heads, tails, fins, entrails etc.--from fish canneries and in some cases the whole fish (dog-fish, menhaden, etc.) is used. The raw scrap is cooked with steam and then pressed, dried and ground for the market. This treatment removes the greater part of the oil, undesirable in a fertilizer, and makes a product which will keep on storage. Much of the fish scrap meal manufactured is used in the preparation of mixed fertilizer.

"The composition of fish scrap meal varies greatly, depending on the nature of the raw product and to some degree on the method of manufacture. Average fish meal manufactured for fertilizing purposes will contain from 6 to 8 per cent of nitrogen and from 5 to 8 per cent of phosphoric acid; when whole fish make up the major part of the scrap e.g. dog-fish, the phosphoric acid content may be as low as 2 per cent. The nitrogen and phosphoric acid of fish scrap become readily available in the soil." (Dept. of Agriculture, Bull. #92, 1927.)

"Acidulated fish scrap" is the term used for the pressed scrap after treatment with sulphuric acid, which prevents putrefaction or fly-breeding and renders the phosphorus in the phosphate of lime available. Fish scrap thus treated is unfit for feeding purposes.

Fish Glues, Gelatin and Isinglass.

The following extract from the second report of Adhesive Research Committee for Great Britain, 1926, is in general applicable to the industry in Canada:

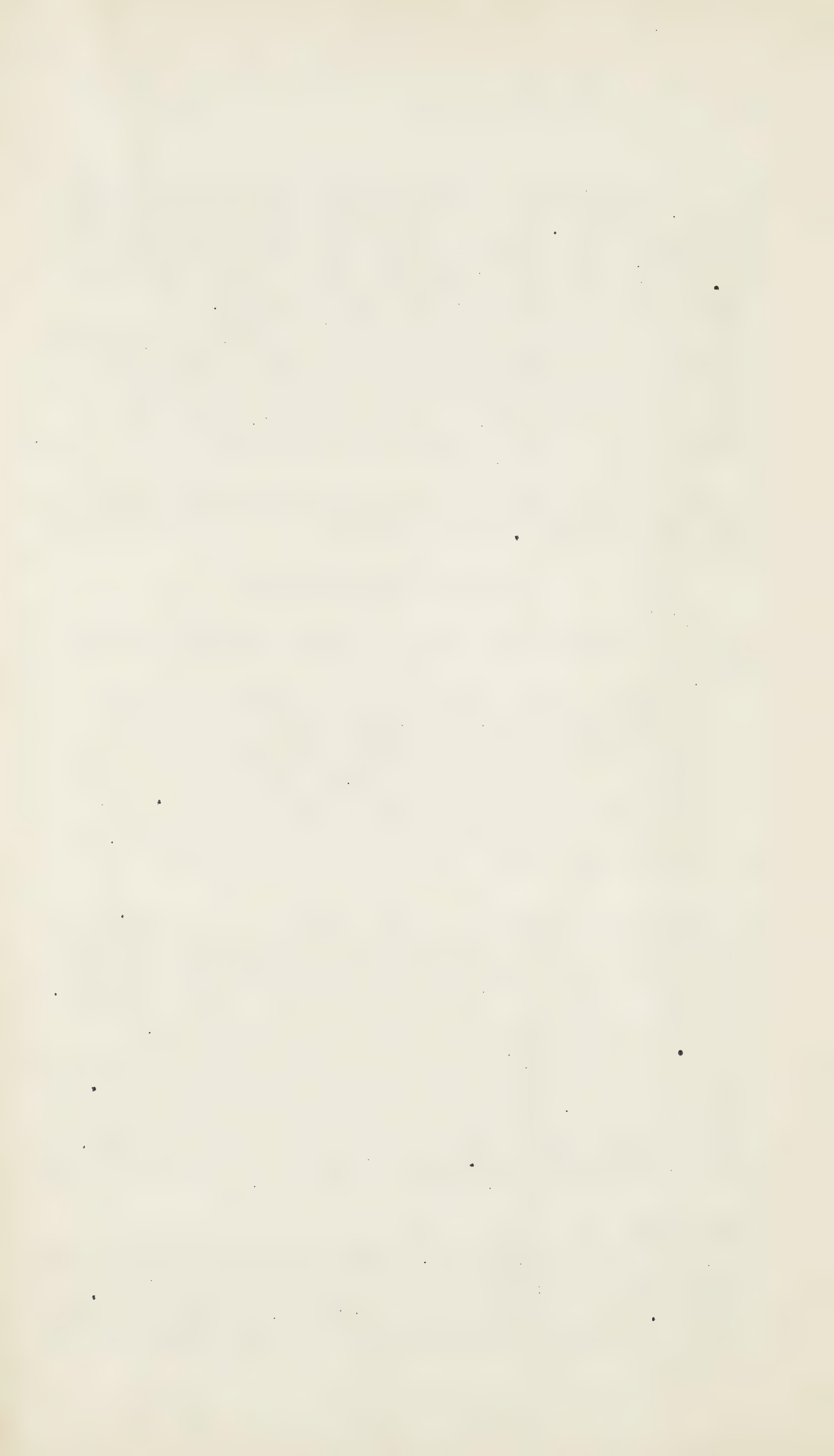
"At present the fish glue industry is small and its products much inferior to bone and hide glues. Only a very small proportion of the raw material available is actually used for glue manufacture, by far the greater part of it passing direct to meal and fertilizer works. The amount of glue produced is sufficient to meet existing demands, but if a greatly improved product could be obtained, and especially if gelatin of high quality could be cheaply produced, other markets would become available. Much of the gelatin used in Great Britain for edible and photographic purposes is imported." (p.23 of report.)

The essential difference at present between the glue as commonly made from fish stock and that made from hides, horns and hoofs is that, owing to the smaller content of true gelatin and the larger content of proteoses, fats and pigment, fish glues are soluble in cold water, while hide glues merely swell in cold water and do not dissolve until the water is heated. Fish glues as made by the usual methods are liquid glues; cake glue from fish is now made but requires great care in the drying process.

Both types of glue, fish or animal, depend for their adhesive qualities on very closely similar gelatins, and research into methods of treatment and analysis of raw material show that glues of high grade can be produced from either source. Tests made at the Royal Air Force establishment in England indicate that the cake glue properly prepared from cod skins compares not unfavourably with the strongest available hide or bone glue. Further, it is possible without great difficulty to produce from fish skins a cake gelatin, colourless, odourless and tasteless.

Raw material

Nearly all the fish glue made is derived from the waste products of cod, haddock, hake and pollock, i.e., from 'ground' fish. Though any kind of fish might be used, various reasons are a bar to their use. Thus, excess of oil, too thin skins or too small bones, short season run, or locality of catch are obstacles to commercial use. In England a fish glue is made at fish-scrap factories from the water in which the fish have been cooked.



The 'ground' fish waste is of three classes (1) skin stock, mainly of salted cod and cusk, (2) trimmings and bones, (3) fish heads. Cod and cusk skins yield 60 - 80 gallons of glue a ton of stock; hake, haddock and pollock, 35 - 45; trimmings, 25 - 30 gallons; heads, 18 gallons per ton. The best raw material is the skin of cartilaginous fish which contains a large proportion of collagen and fewer fat glands. Thus, though catfish are much used, they yield a lower grade of glue owing to the amount of fat in the skins. Ordinary fish offal, because of the variety of its ingredients, and even salmon offal is not suitable for glue of high quality, but the waste of the cod, hake and haddock from the filleting factories now common provides a ready and valuable supply of raw material. Sharks, non-edible and undersized fish are further sources, provided that for economic reasons the residue after glue extraction can be made into fish meal and other by-products.

Uses

The best grade of fish skin glue is found to be the most satisfactory 'photo-engraving' glue for the enamel process, and its manufacture for this delicate purpose requires the utmost care.

Large quantities of the cheaper grades of fish glue are used for sizing.

Ordinary fish glues are not the best for woodwork, because of their hygroscopicity and odour, but the improved fish glues, having neither of these drawbacks and also a high tensile strength, are quite suitable for use in joinery and for similar purposes. These now odourless glues can well be used for veneer work, manufacture of cartons and paper boxes.

Ordinary fish glue is also used as a ready-to-use adhesive for the shoe trade and for repair jobs generally. Its use as mucilage has its odour disguised by flavouring extracts. It is largely used where flexible glues are required, as for court plaster, labels, stamps and book-binding.

An edible gelatin, colourless, odourless and tasteless, can by a special process be produced from selected skins and a gelatin suited to photographic plates at a lower cost than those now marketed for the same purpose.

The Method of Manufacture for ordinary fish glue consists mainly in:

- (i) elimination of the salt,
- (ii) cooking with the addition of a preservative and also of an acid to hasten the hydrolysis of the stock.
- (iii) filtration of the liquor, and evaporation either in vacuum evaporators or in open pans heated with steam coils until the proper viscosity is attained.
- (iv) addition of further preservatives, such as phenol, and of essential oils, such as wintergreen, peppermint, etc.

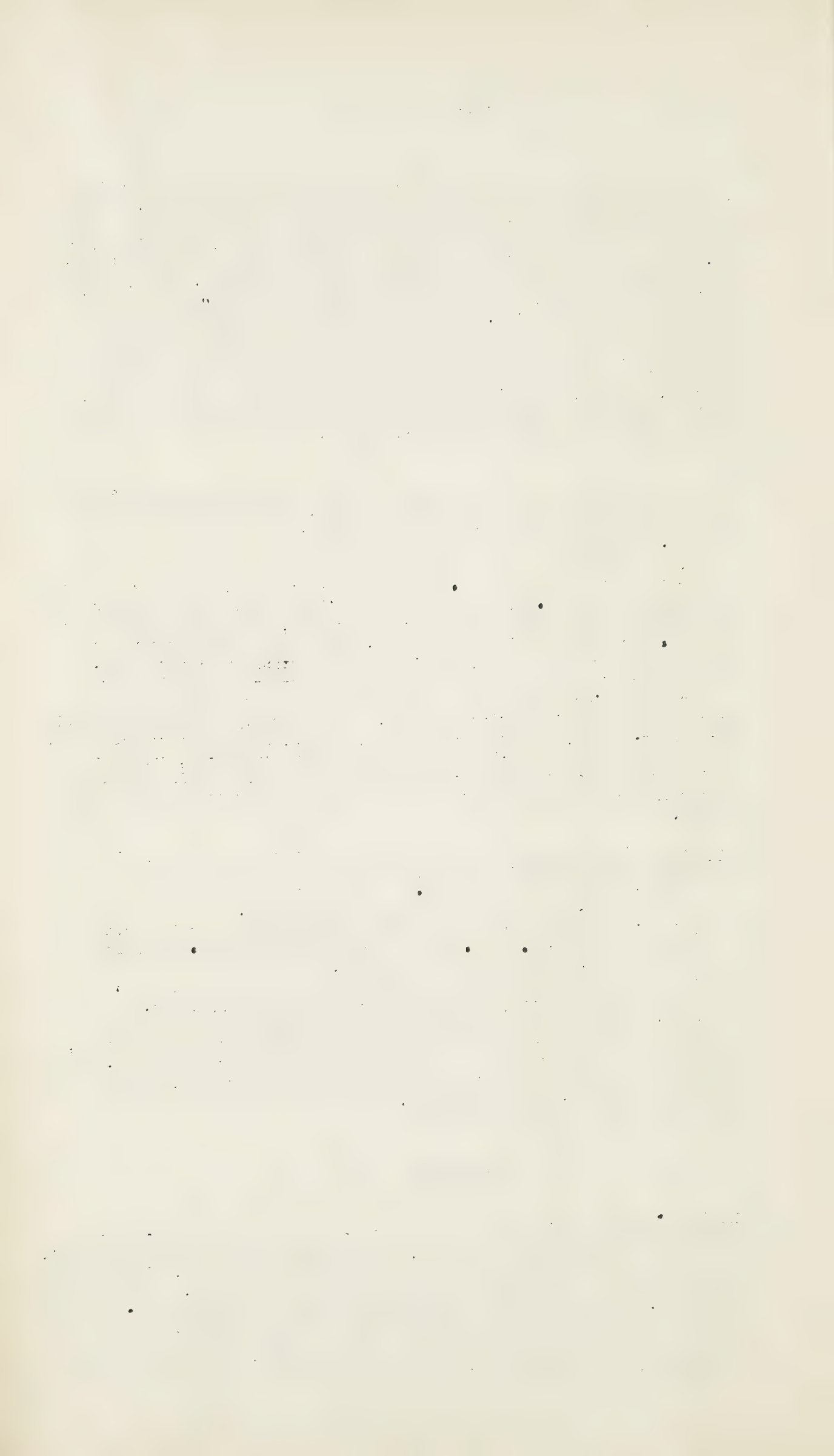
The 'chum' or residue, from the above treatment is an excellent poultry food with a content of 50 per cent of easily digestible protein, besides a good deal of calcium for eggshell and phosphorus for yolk. An average analysis of this 'chum' shows 53 per cent protein, 27 per cent calcium and magnesium phosphate.

Isinglass

Description and source

Isinglass is a collagen contained in a certain layer of the air-bladders, or swim-bladders, of fish. These bladders are known as 'sounds'. Isinglass does not dissolve, but merely swells in cold water. The collagen does not become gelatin until it has been heated with water. When thus heated it hydrolyzes to form a gelatin which dissolves and which on cooling forms a gel closely resembling that of hide or bones gelatin.

The best known isinglass is the Russian variety made from the sounds of sturgeon, catfish and carp. In Iceland cod and ling sounds are the



chief raw materials; in Newfoundland and the North Atlantic, hake and cod. American isinglass is also made from the 'squeeteague', known also as 'yellow fin', 'weakfish', 'blue fish' and by other names, which is caught in large quantities along the coast of the middle Atlantic states. Good grades of isinglass are also manufactured in India, the Philippines, Venezuela, Brazil and the West Indies, but there is no firm listed as now manufacturing this valuable material in Canada. Apparently the only fish from which sounds are saved in Canada for isinglass making is hake and the combined output of 35 or more collectors amounts to only 25,000 lbs., all of which is exported to the United States.

Process of Manufacture

The best quality of American isinglass is prepared from the sounds of hake caught in deep waters off the coast of Nova Scotia. The sounds are removed when the fish is dressed and, if far from land, are salted in barrels. One ton of hake yields from 300 to 500 large bladders or sounds weighing 40 - 50 lbs. At the factory these are split up and dried in the open air; later they are soaked till soft, chopped, macerated and rolled into sheets $1/8$ in. - $1/4$ in. thick and 6 in. - 8 in. wide, of any length. Finally these sheets are passed through ribbon rollers producing ribbons $1/64$ inch thick, which are quickly dried and wound on wooden spools into coils about 1 pound in weight. Owing to the value of isinglass, it is adulterated by gelatin, blood fibrin, agar-agar, etc. Occasionally gelatin is rolled in between layers of isinglass, a fraud easily detected by the microscope which shows the fibrous structure retained by the isinglass, but not by the gelatin.

Uses

Owing to the perfected processes of beer filtration, isinglass is not much used now as a fining agent for beer, but is still the chief agent for the clarification of white wines. One ounce of isinglass clarifies up to 500 gallons of wine in eight or ten days. The isinglass, not being heated, retains its fibrous structure even when beaten up and stirred in, but being held in finely divided suspension mechanically entangles in its meshes as it settles the material in the wine that causes turbidity.

As a result of the ability to produce gelatin from fish skins which is odourless, colourless and tasteless, the Adhesives Research Committee investigated the possibility of using prepared fish skins (cod, haddock, etc.,) for clarification of fermented liquors. That this is possible is implied by the use of skate skins in France for the clarification of wines, but the exact conditions for success were not yet (1926) formulated.

As very pure gelatin can now be produced by the electro-osmose process quite cheaply even from low-grade materials, isinglass is no longer used in the preparation of edible jellies and confectionery, but is of value in the sizing of silk, in making cement for broken glass and china, court plaster and capsules, a water proofing compound for textiles and a dressing for leather.

Pearl Essence, for use in the artificial pearl industry, is the shiny extract from herring scales.

For several years the raw material has been shipped from Grand Manan and elsewhere in New Brunswick, but the establishment of a 'pearl essence' extracting plant at Nanaimo, B.C., is of recent date. This plant has a capacity of 3-5 tons a day and, in 1927, 150,000 pounds of herring scales were treated. The essence is shipped to the Paisperd Products Company, the parent firm in New York for final conversion into 'pearls'.

Poultry Grit

A minor by-product of the fishing industry is the poultry grit derived from scallop, clam and lobster shells. A specialty of scallop and clam shell grit is made by a producer at Digby, N.S.

A chief market is Bristol, England, but shippers have there to compete with the long established sale of oyster-shell grit from Baltimore, U.S.A., which realises from \$17.50 to \$20.00 a cwt.

Lobster shells from Labrador are also likely to compete in the market. (Com. Int. Journal 1926, p. 105).

Regulations etc.

Licenses

"Except as in this Act otherwise provided no one shall engage in the manufacture of fish meal, fertilizer, oil, glue or other products of a similar character from fresh fish, fish offal or marine animals except under license from the minister." (Sec. 10, Fisheries Act.)

The use of nets, other than gill-nets, drift nets, drag seines or purse seines shall not be permitted in the capture of herring or pilchard.

The license fees for a drift-net or gill-net shall be one dollar; for a drag seine or purse seine five dollars. (Fishery Reg. for B.C. Sec. 14.)

Dogfish

The name "dogfish", the vernacular name for squalis, is hereby changed to "grayfish". (Sec. 64, Fisheries Act).

The fee on a license to authorize net or hook or line fishing for grayfish shall be one dollar. (Fishing Reg. for B.C. Sec. 13.)

Herring

The capture of herring for reduction into fish, meal, oil, etc. is permissible in districts 1 and 2, British Columbia but not in District 3.

(District 3 embraces (a) all the territorial waters of British Columbia on west coast of Vancouver island between Beachy Head and Cape Scott and (b) all those between the east coast of Vancouver island and the mainland to an imaginary line drawn from Cape Scott to Cape Caution.)

The capture of herring for reduction is permissible on the Atlantic coast in the Bay of Fundy waters adjacent to New Brunswick. Also spring herring caught on the Atlantic coast may be converted into such products.

Pilchard

There is no restricted area for capture of pilchards, nor any close season.

Taxation

In 1925 the British Columbia Legislature imposed a tax of \$1.25 a ton on fish meal and one cent a gallon on fish oil made in the province.

Fish Oils - Inspection

Revised Stat. of Canada, 1906, Chap. 85.

Inspection and Sale Act with amendments to August, 1920.

Under this Act all fish oils including whale shall be classified and branded by inspectors.

Whale and porpoise oil No. 1 pale, No. 2 straw, No. 3, brown, Seal oil No. 1 strictly pale, No. 2 pale, No. 3 straw, No. 4 brown, No. 5 dark brown.

Cod and all other oil A 1st quality, B 2nd quality.

Casks to be marked with the gauge of cask and the barrels to be sound and staunch, made of hard wood. Water or adulteration in cask to be inscribed on cask.

Fees for inspection 20 cents a puncheon (72 gal.)
 15 cents a hogshead (54 gal.)
 20 cents a tierce (42 gal.)
 15 cents a barrel (36 gal.)
 empty packages barrel 1 cent.

Inspection either at factory, or at place of sale.

N.B. Nothing in this Act shall oblige any person to cause any article to be inspected, but, if inspected, it shall be subject to the provision of this Act. (Sec. 32.)

Sec. 31 "Whenever an article is sold subject to inspection, the person applying for such inspection shall be entitled to reimbursement of the cost of inspection from the vendor, if such applicant is not himself a vendor, unless an express stipulation to the contrary is made at the time of the sale or of the agreement to submit to inspection."

"Such agreement to submit to inspection shall imply a warrant that the article in question is of the quality for which it is sold, and that all the requirements of this Act have been complied with..... unless it is otherwise expressly stipulated."

Analyses

Below are analyses of fish meal for feed and fish scrap for fertilizer taken mostly from the 1922 to 1926 Reports of the Dominion Chemist.

	Moisture	Protein	Fat	Ash	Phos. of Lime
Fish meal from St. John, N.B.	7.24	27.51	.70	60.08	33.81
Fish meal from St. John, N.B.	14.00	43.94	2.61	34.07	26.77
Salmon offal meal B.C.	7.49	58.84	9.70	13.64	13.55
Dogfish meal, B.C.	7.46	54.20	10.25	15.47	11.21
Waste from Port Maitland, N.S.	44.62	30.70	1.09	23.64	---
English fish meal (imported)	5.62	58.32	6.99	26.77	
Meal from shark, dogfish, skate, Sooke, B.C.	4.85	50.08	27.20	14.86	
Meal from Errington, B.C.	9.61	60.24	15.73	13.44	
" " Deer Island, N.B.	19.67	42.90	11.64	14.65	
" " Fairhaven, N.B.	20.09	55.81	7.21	16.36	
" " " "	32.86	38.95	7.60	19.01	
	Moisture	Protein	Oil	Salt	Phos. of Lime
Fish meal Halifax, N.S.	9.43	68.71	2.88	1.82	17.32

Analyses (cont'd)

<u>Fertilizer</u> (raw material)	Water	Nitrogen	Phos. Acid	Potash	Salt
Fish refuse from Berwick, N.S.	46.40	3.87	4.43	0.43	18.71
	Moisture	Nitrogen	Phos. Acid	Fat	
Fish refuse from St. John, N.B.	55.76	3.95	2.77	4.17	
" " " Gaspe, P.Q.	6.35	3.62	5.80	4.47	

Note. The variations in the above analyses are due in many cases to the thoroughness with which the preparation has been carried out. Thus if a moisture content is reduced from 40 or 50 to 10 per cent, the nitrogen and phosphoric acid content may be nearly doubled. For the keeping qualities of a fish meal much of the oil should be extracted, though the nutritive value is thereby reduced. A good fish meal may contain as much as ten per cent fat (preferably 3%) but a fertilizer not more than 3%. The percentage of phosphate of lime varies according to the amount of bone in the raw material.

In Canada fish meal should be prepared from fresh raw fish or fresh offal dried without scorching and should contain 55-60% protein less than 10% fat, 3 per cent salt, net over 14% moisture. The English standard is 55 or more protein, 15% calc. phosphate, and not more than 5 per cent fat and 4 salt.

Percentages in analyses of various prepared scraps.
(Journal Ind. & Eng. Chem. 1924).

	Nitrogen	Phos. Acid	Oils	Moisture
Dog-fish scrap	12.15	3.59	7.89	6.35
Sardine "	7.97	7.11	8.42	5.57
Tuna "	8.54	7.25	13.27	4.21
Whale Meal	11.59	0.94	12.70	5.41
Shark waste	9.34	1.99	trace	13.93
Fish meal	6.54	4.78	---	---
(Meat Meal)	(8.57	4.56)	---	---

Tariff Items Relating to Fish By-Products.

Item 467 a Machinery of a class or kind not made in Canada or the parts thereof for the manufacture of fish meal stock and poultry food and fertilizers from fish and the waste thereof:-

Free

Item 663 b Articles which enter into the cost of the manufacture of fertilizers when imported for use exclusively in the manufacture of fertilizers:-

Free

Item 1046 Materials are subject to a drawback of 99 per cent when used in the manufacture of articles entitled to entry under tariff item 663 b when such articles are sold to manufacturers to be used as specified in said item.

Item 662 Fish offal:-

Free

Item 265 Oils, spermaceti, whale and other fish oils including cod liver oil:-

British Preferential	French Treaty	Intermediate	General
12%	20	20	22½

Item 232 Glue, liquid, powdered or sheet and mucilage, gelatine, casein, adhesive paste and isinglass:-

British Preferential	French Treaty	Intermediate	General
17½	25 - 10% (Under Australian agreement 12½)	25	27½

Item 133 All other articles the produce of the fisheries, n.o.p.

British Preferential	French Treaty	Intermediate	General
15	20	20	25

Item 227 Whale oil soap:-

Free

Item 635 Whalebone unmanufactured:-

Free

Note: Importations under tariff item 467a are subject to the sales tax of 3 per cent on the customs duty paid value in accordance with resolutions effective Feb. 17, 1928. Specifications of machines to be actually imported and particulars as to the exact purpose for which they are to be used must be furnished.

Markets

Fish Meal Market

Since fish meal in the last decade has been found to be an important feed for stock and poultry, the market area has greatly enlarged and widened.

During the war a hundred million cut-off heads of herrings imported for food from Norway yielded nearly 200,000 lbs. of oil and 800,000 lbs. of meal. The waste after the meal had been utilized for 'soup seasoning' by boiling with hydrochloric acid was worked up into cattle feed.

In 1923	Germany	imported	6302	tons	of	fish	meal
In 1924	"	"	26993	"	"	"	"
In 1925	"	"	45700	"	"	"	"
In 1926	"	"	82000	"	"	"	"

The estimated consumption in Germany for 1927 was 100,000 tons of which domestic production could supply 10,000. Canada supplied 2 per cent of the 53,000 tons imported in the first 6 months of 1927.

Great Britain which before the war used to export some 3,000 tons of fish scrap to Germany for fertilizer is now consuming the 40,000 tons produced domestically mainly for feed purposes. Japan, long an importer of fish guano for fertilizer, is now considered as offering a big prospective market for meal.

Canada, Newfoundland, the United States, Norway and Great Britain are alone in a position to supply the growing demand. India, South Africa, South America and perhaps some other countries contribute somewhat but can more readily supply fish scrap for fertilizer than fish meal of standard quality. India Produces 35,000 tons of fish scrap and guano.

As Great Britain and the United States are now awake to the poor economy of exporting animal feed and fertilizer, the probability of their having surplus for exports diminishes. Canada, Newfoundland and Norway, which produces about 10,000 tons of codmeal and 40,000 tons of herring meal a year, may therefore be considered the dominant exporters, because in each country the potential supply of meal is greatly beyond the demand for it in the agricultural industry, and each country has a very extensive sea area from which the raw material can be drawn.

There is a market in Germany for nearly all kinds of fish meal, which is used mainly for hogs, but also for poultry. An excess of 3% salt is thought detrimental and the less the fat and the more the protein content the better.

Holland is also a large importer of meal via Rotterdam, especially that of light colour analysing 50-55% protein, 25-30% phosphate, salt max 3, fat max. 3. Pilchard and herring meal also find a market. Canadian pilchard meal is now of a high quality. The first considerable shipment (10897 bags) from Vancouver to Hamburg was in November 1927. A list of importers in Holland is on file at the Department of Trade and Commerce, Ottawa (file No. T.C.8-119).

The difficulty so far in getting high prices for Canadian meal has been that for a long time fish meal was considered only as fertilizer and was manufactured from unsterilized scrap or from by-products of the fish glue industry. Another reason has been the practise of drying the offal by hot air or flame, which scorched or darkened the product, instead of by the indirect steam and solvent processes usual in Germany and England. A booklet describing the scientific German method can be obtained on loan from the Commercial Intelligence Service of the Department of Trade and Commerce, Ottawa, where samples of good Scotch fish meal can also be seen. (Reference file T. & C. 20382.)

Modern Methods of Utilising Fish Waste for the Meal Market in England.

In 1891 not more than 5 shillings a ton was paid for fish waste; the ruling price now is 63 shillings a ton.

The up-to-date fish meal factories in Hull, on the Yorkshire coast, produce a meal which from the very first has been as carefully handled as food for human consumption. In these factories nearly all the trawler owners, fish curers and fish merchants are shareholders.

The main points in the treatment are that the fish waste is quite fresh to begin with, that the floors and equipment of the factory are kept perfectly clean by the use of steam and chemicals, that the drying process is enclosed and continuous, and the material is sterilized; that the gases are all washed and burnt out, that, by the use of the most modern machinery, steam consumption, horse power and labour cost are reduced to a minimum; that temperatures at each stage of preparation are carefully regulated; and that there is a total destruction of all offensive vapours.

The results are that the drying now takes $2\frac{3}{4}$ hours instead of 8; the meal is lighter in colour, has greater feeding value, is free of any disagreeable odour and keeps better owing to sterilisation; that within

3 hours from the splitting of the fish in the curing houses the waste is in the factory and within 3 hours the meal is already bagged for transit, and finally that the premises and neighbourhood no longer offend the nasal organs of the most rigid sanitary inspector.

Fish Oil Markets.

The U. S. A. took 80 per cent of Canada's fish oil exports in 1927. Glasgow, Liverpool and Hull are the chief British markets especially for oil of a high quality suitable for hydrogenation.

Packages

Norwegian shipments to Hamburg are made in jute sacks containing 220 lbs. (110kg.) 10 to a ton. Canadian shipments are usually made in sacks containing 112 lbs. (20 to the long ton). Though this capacity is suitable for the English market, 110 lb. sacks are advised for Hamburg, as the dealers there buy in 50 kg. lots. Used clean cotton flour sacks or other used cotton bags if free of chemical odour are also used. Oil shipment in steel drums is preferable to that in wooden casks.

Trading is effected either through a canvassing agent in Hamburg or a 2% commission, or by contract with a reliable importer for a minimum supply over periods of 6 to 18 months. The Canadian Trade Commissioner should be supplied with samples and guaranteed analysis.



Value of Fish By-products in 1925, 1926

<u>Oil</u>	<u>1925</u>	<u>1926</u>
Cod liver	\$ 22,875	\$ 57,459
Cod	103,126	74,987
Pilchard)		734,078
Fish n.e.s....)	331,564	121,396
Whale	266,651	223,864
Porpoise and seal	4,215	3,575
	<u>\$728,431</u>	<u>\$1,219,359</u>
<u>Meal</u>		
Pilchard	\$	\$371,365
Fish	239,034	226,110
Whale	7,260	9,633
	<u>\$246,294</u>	<u>\$ 607,108</u>
<u>Fertilizer</u>		
Fish	\$ 47,434	\$ 45,957
Herring	70,329	77,641
Pilchard	24,021
Whale	35,697	36,630
	<u>\$153,460</u>	<u>\$184,249</u>
Blue	13,200	16,320
Scales (herring) .	14,652	...
Offal and bones ..	23,753	38,887
	<u>\$1,179,790</u>	<u>\$2,065,923</u>
Percentage of total value of fisheries	2.45%	3.66%

	<u>Imports</u>				<u>Exports</u>	
	<u>1925</u>	<u>1926</u>	<u>1927</u>	<u>1925</u>	<u>1926</u>	<u>1927</u>
Cod liver oil	\$ 87,731	\$123,951	\$199,183	\$108,504	\$181,116	\$182,458
Other fish oil	27,863	23,325	26,097	43,377	174,656	700,539
Seal oil	39,903	21,588	56,044	30,132	10,992	6,739
Whale and sperm aceti ...	128,496	2,345	19,937	417,360	242,627	168,390
Offal	1,908	4,157	7,056	31,834	94,926	254,773
Meal and fertilizer	71,462	67,631	71,629	53,380	166,737	499,945
Machinery for fish meal indus- try equipment	18,335	164,544	293,507			

Note in the above figures for production, imports and exports:

- (i) the increase in production of oil and meal in 1926 and in the exports of these for 1926 and 1927;
- (ii) the amount of fish offal exported, which, if processed in Canada, would be raised in value at least five-fold.
- (iii) the amount of fish meal machinery imported in 1926 and 1927.

Prices

Fish Meal

Grades at Hamburg, Nov. 1927.

	Quality	Protein	Calcium Phosphate	Salt max.	Fat max.	Price per 110 lbs.
Norwegian						
	(1) Flaky	50%	13%	3%	3%	5.53
	(2) Granular	52%	20%	3%	3%	5.47
Icelandic						
	Steam dried cod.	52%	20%	3%	3%	5.00
North American						
	White fish meal	55%	15%	3%	4%	5.00
	"Nordkap A" Fresh fish meal	60%	10%	3%	8%	4.40
		60%	10%	3%	8%	4.34

English and Scotch

White fish

meal

55-65%

15-25%

3%

4%

--

(Sells at a rather lower price than Norwegian 'flaky', which is lighter in colour, made from air-dried material and with a very highly digestible protein.)

Hamburg terms are f.o.b. cars, at least 5-ton lots, prompt delivery, cash payment. The average price of fish meal in 1926 was \$87 a metric ton.

The busiest month in the Hamburg market is usually November; in summer it is dull. Shippers to Hamburg via Glasgow should allow 11 shillings a ton for this trans-shipment. Prices in several months of 1927-8 show the following variations expressed in English pounds sterling:-

Norwegian cod - £19 - £22-10-0 per 2204 lbs. (1000 kg.)

Scotch white £18-10-0 - £20 " long ton

English " £18 - £19-10-0 " "

N. American " £18 " "

N. Pacific

pilchard £15-10-0 - £17 " "

Norwegian

herring £15-10-0 - £16-15-0 (2204 lbs.)

(The first considerable shipment of pilchard meal from Vancouver to Hamburg (10897 sacks) was in November, 1927.)

Fish Oil - (Canada prices, April 1928.)

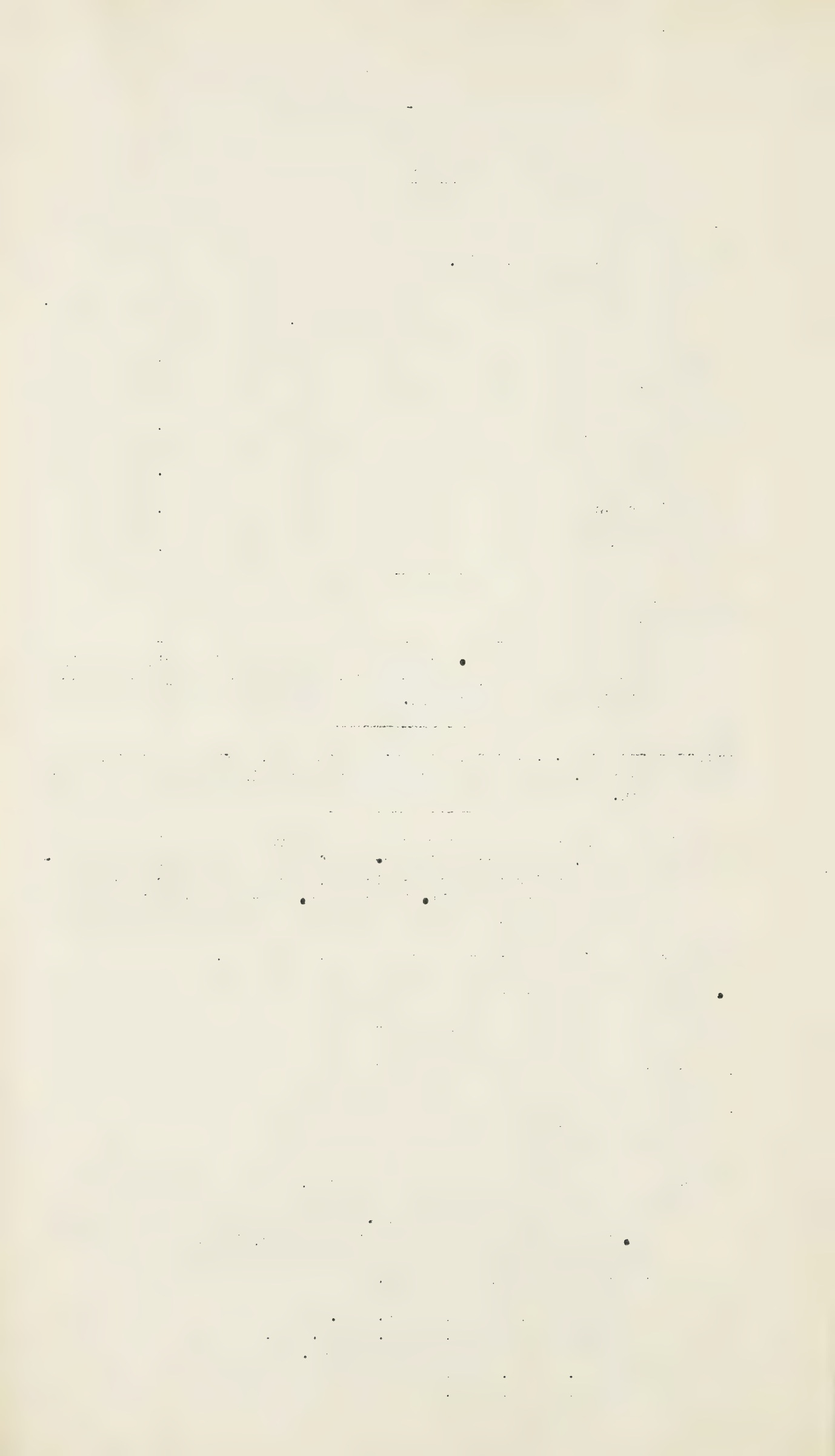
Cod Oil (domestic) 0.72 - 0.75 imp. gal.

" " (Newfoundland) 0.76 - 0.82 imp. gal.

Cod liver oil (") 0.56 - 0.60 (25 gal. barrel)

Whale oil crude No. 1. .09 lb.

No. 2 .08 lb.



Whale Oil Refined • .95 Gal.

" " Bleached \$1.05 "

Pilchard Oil average prices 1923-25 was .90 a U. S. gallon.

Herring Oil " " " " " " "

Oils of very light colour with not more than $\frac{1}{2}$ to 1% fatty acid fetch top prices which may be as high as £37-£40 a long ton in Europe. Inferior oils may be as low as £17-18.

Fish meal fertilizer (guano) - Price in B.C. March 1928 - \$65 a ton.
(Price depends on analysis and small percentage of oil. The average price for guano with not more than 8% oil c.i.f. Liverpool was £10 a ton - 1923-5.)

Lobster shells (dried, ground, free of sand) c.i.f. Hamburg £10-11 a long ton.

Scallop and clam shell grit for poultry has to compete in price with the oyster shell grit from Baltimore selling c.i.f. Bristol (Eng.) at \$17.50-\$20 a cwt.

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Fish By-product Plants in Canada

<u>Name</u>	<u>Place</u>	<u>Product</u>
<u>Nova Scotia</u>		
Robinson Glue Co.	Canso	glue, meal
C.W. Monball	Halifax	meal, oil, guano
Easterhat Ltd.	Halifax	meal oil
Liverpool Refiners	Liverpool	oil
Ceasnic Fertilizer Co.	Lockeport	oil
H.R.L. Hill	Lockeport	oil
A.W. Dodd Co.	Westport	oil
A.W. Dodd Co.	Tiverton	oil
Parkhurst Cod Liver Oil Co.	Tiverton	cod liver oil
Roy Cassey	Victoria Beach	oil
Lewis Cannery Co.	Digby	poultry grit (clam & scallop shells)
<u>New Brunswick</u>		
Wentworth Bros.	Fairhaven	meal, oil
Connors Bros.	Black's Harbour	" " guano
Russian Cement Co.	St. John	glue
Maritime Rendering Co.	St. John	glue, meal, guano
<u>British Columbia</u>		
Anderson Fisheries	Ucluellet (Vanc.I.)	meal, oil, guano
Californian Packing Corp.	Ceepeesca "	" " "
Canada Fishing Co.	Cooprino Harbour (Vanc.I.)	" " "
Canada Fishing Co.	Buteedale (Princess Royal I.)	oil
Canada Fish Products Ltd.	Watt I. Ladner	meal, oil, guano
Consolidated Whaling Corp.	Naden Harbour	oil, bone, meal & fertilizer
Consolidated Whaling Corp.	Rose Harbour	oil, bone meal & fertilizer
Foro Fish Products Ltd.	Sidney (Saanich)	meal, oil, etc.
Gosse Packing Co.	San Mateo (Van.I.)	" " "
Tosse Packing Co.	Hecate Channel	" " " "
Hecate Fish Products	" " "	" " " "
Lord, Leavell Fisheries	Sydney Inlet	" " " "
Marine Products	Toquart	" " " "
Matilda Creek Fisheries	Matilda Creek	" " " "
Manitoba Reduction Works Ltd.	Manitoba	" " " "
Nootka Packing Co.	Nootka	" " " "
Northern Packing Co.	Eccole	" " " "
North West Fisheries	Matilda Creek	" " " "
Orion Fishing & Packing Corp.	Cashlot	" " " "
Pender I. Fish Products Co.	Pender I. (Georgia Str.)	" " "
Rupert Marine Products Ltd.	Tuck Inlet	" " "
Sackart Fisheries	Sackart (Vanc. I.)	" " "

<u>Name</u>	<u>Place</u>	<u>Product</u>
Shelter Arm Fisheries	Shelter Arm, Vanc. I.	meal, oil, etc.
Star Construction Co.	Sooke Spit, "	" " "
Wallace Fisheries 2'	Kildonan, "	" " "
Wallace Fisheries	Quatsino, "	" " "
Paisperd Products Co.	Manaimo, "	pearl essence

The above plants were registered in 1927. Besides these are firms or parties which render oils and collect fish products for refiners and factories.

Among these are:

S.L. Dakin	N. Sydney, N.S.	cod and cod liver oil, seal and whale oil
A.W. Fader Ltd.	Canso, N.S.	
Leonard Fisheries Ltd.	" "	
F.T.B. Young	Lameque, N.B.	
Robin Jones & Whitman	" "	

In 1927 there were no plants operating in Prince Edward Island, Quebec or the freshwater lakes.

U. S. GEOLOGICAL SURVEY

WASHINGTON

1911

Department of the Interior
Bureau of Reclamation

U. S. GEOLOGICAL SURVEY

WATER RESOURCES DIVISION
FISH REDUCTION PLANTS
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RECLAMATION PROJECTS

PLANT 1, RECLAMATION PROJECT, 1911
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